

TWO WHEELED VEHICLES E20 FUEL MAGNETIZATION STUDY ON EXHAUST GAS EMISSIONS

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ABSTRACT

Research on the magnetization of fossil fuels that can improve the quality of combustion has been done but magnetization for fossil and non-fossil fuel mixtures such as bioethanol and gasoline mixtures has not been done. Therefore, this study aimed to analyze the effect of magnetizing the mixture of gasoline (premium) and bioethanol related to the quality of combustion, especially exhaust emissions on two-wheeled vehicles (motorcycles) as 4-stroke with 125 cc engine capacity. During the experiments, CO, NO_x and SO₂ as the gas emissions were measured using a NOVA2000 Gas analyzer. The composition of the fuel used is E20. This fuel has flowed through electromagnetic fields with a strength of 647.15 Gauss, 847.25 Gauss, 1068.29 Gauss, and 1419.57 Gauss. Our study showed that when the mixture of fossilized fuel-bioethanol is magnetized, the resulted exhaust emission of CO, NO_x, and SO₂ will be plummeted by 48%, 68%, and 76%. Moreover, the combustion energy increased by 0.641%. Henceforth, this study improved previous papers such as Faris et al. [1] and Patel et al.[2] that used a magnetic field strength greater than 2000 Gauss, also Jain & Deshmukh [3] employed a magnetic field strength less than 2000 Gauss.

KEYWORDS: Magnetization, Bioethanol, Gasoline & Exhaust Emissions

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NOMENCLATURE

E20	(80% Premium and 20% Bioethanol)
CO	Carbon Monoxide
NO _x	Nitrogen Oxide
SO ₂	Sulfur Dioxide

INTRODUCTION

The use of gasoline engines for transportation purposes is increasing. The situation is not following government policy in the energy sector, which seeks to use petroleum fuel as economically as possible, considering that petroleum is a non-renewable energy source. Later on, this unsustainable demand will cause an energy crisis. This energy crisis caused people to change their mindset to further intensify research and use from non-renewable energy to renewable energy.

The increasing demand for gasoline engines for transportation has contributed partly to the energy crisis recently. Not only because of the decrease of oil reserves gradually, but also oil's inability to renew its source. Thus, to reside with the government policy in the energy sector, petroleum fuel must be utilized economically. Later on, the energy crisis has taught society to switch from non-renewable energy to renewable energy.

Meanwhile, the motor vehicle exhaust gas mission has become the main source of air pollution, especially in urban areas. Although motor vehicle exhaust gases consist of non-hazardous compounds such as nitrogen, carbon dioxide, and water vapor, it also contains a large number of other compounds that can endanger the health as well as the environment. Contaminants contained in motor vehicle exhaust gases are carbon monoxide (CO), various hydrocarbon compounds, various oxides of nitrogen (NO_x) and sulfur (SO_x). The exhaust gas is released into the air due to evaporation from the fuel system [4][5].

In the spirit of appreciating the renewable energy, we want to design an environmentally friendly energy pulse. In this particular experiment, we choose ethanol or bioethanol. Based on the above, we need an environmentally friendly energy pulse, one of which is ethanol or bioethanol. Bioethanol cannot be 100% used as a substitute for fossil fuels. In order to use on gasoline engines, this bioethanol must be mixed with fossil fuels. In this research, the fuel used is E20 (20% bioethanol + 80% premium). This fuel flows through a magnetic field as a fuel saver. Many papers already studied the effect of magnetization on exhaust gas emission using fossil fuel [1] [2] but none of them studied the effect of magnetization on exhaust gas emission using mixed fuel, especially E20 fuel. Therefore the purpose of this study is to analyze the effect of E20 fuel magnetization towards its exhaust gas emission on two wheels vehicle.

The hypothesis we investigated is the fossil fuels mixed with bioethanol and which are flowed through magnetic fields will be able to improve engine performance, which is indicated by decreasing levels of exhaust emissions and increasing combustion energy. Therefore, the purpose of this study is to analyze the fuel magnetization of gasoline engine performance.

BACKGROUND

The effect of magnetic fields on fuel consumption and exhaust emissions on a 1-cylinder 4-stroke engine has been discussed in the literature. Faris et al. [1] reported that the addition of the magnetic field intensity to the fuel increased the infrared absorption. Therefore, the greater magnet intensity applied to the fuel, the more vibration experienced by CH atomic microstructure. This condition will create more space to oxidize with oxygen and create greater energy attraction between CH atoms. After the fuel was magnetized with a magnetic field intensity of 2000-9000 Gauss, the fuel consumption will decrease by 9-14% and exhaust emissions of HC and CO will decrease by 30% and 40%. This research used permanent magnets, even though this permanent magnet will decrease its magnetic field strength due to vibration and heat. This condition could be improved had we utilised the electromagnetic field because the strength of the field will remain constant as long as the current existed.

Jain and Deshmukh [3] conducted a study of MFC (Magnetic Fuel Conditioner) with a strength of 1000-1800 Gauss on a 5 HP diesel engine with variations in load, this magnetic effect caused a change in fuel molecules from cluster to de-cluster. They claimed to decrease the fuel consumption by 10-30% and decrease the exhaust emissions of HC, CO, and NO_x by 40%. The advantage of this research is that the magnetic field used is relatively small but the results obtained such as fuel consumption are relatively large compared to the Faris et al. [1], while the exhaust emissions are the same as

those obtained by Faris et al. [1]. The weaknesses of this study are the same as Faris et al.[1], which uses permanent magnet.

Patel et al. [2] conducted a study on the use of magnetic fields derived from a mixture of ceramics and iron oxide which produced an intensity of 2000 Gauss magnetic fields on a 4-stroke 1 cylinder engine. Patel explained that the cluster-de cluster effect caused fuel consumption to decrease by 8% and the exhaust emissions of HC and NOx decreased by 30% and 27% respectively after the fuel was magnetized with a magnetic field intensity of 2000 Gauss. Patel's research only uses permanent magnets which change over time as a result of friction, vibration and high temperatures [2]. The study used a magnetic field strength greater than 2000 Gauss, while the reduction in fuel consumption and exhaust gas emissions was the same as Jain & Deshmukh [3] reported, the excess magnets used were made from a mixture of ceramics and iron oxide that had not been studied by other researchers.

Most researchers use permanent magnets with a magnetic field strength greater than 2000 Gauss, as well as using fossil fuel engines. Our study will lead to use electromagnets (non-permanent) with a magnetic field strength of less than 2000 Gauss and the engine uses a mixture of fossil fuels and biofuels. This magnet was placed between the fuel tank and injector as shown in Figure 1, the fuel that passes through the magnet for the initial stage was left for 20 minutes, meaning that the fuel molecules change from clusters to de clusters so that when mixing with air molecules in the combustion chamber it was easier reacting with air. The presence of this magnet does not interfere with other devices [5].

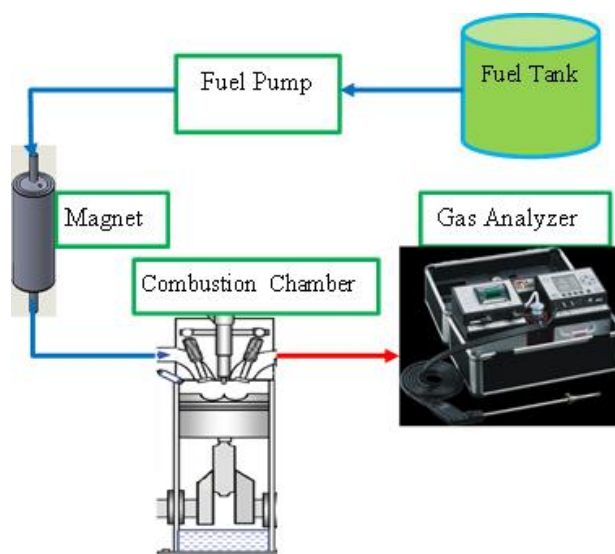


Figure 1: The Position of Magnets on two-wheeled Vehicle Engines.

The choice of E20 in this study as fuel for two-wheeled vehicles, because the composition of E20 is the maximum limit for two-wheeled vehicles that do not need to be renovated. [6]. The short-term research target was to analyze what is the maximum percent decrease in exhaust emission levels due to the influence of magnets on fuel. while the long term is to produce two-wheeled vehicles that were environmentally friendly so that it can reduce air pollution in areas where most residents use two-wheeled vehicles. From this research, it is expected that by using a small magnetic field strength and a strong magnetic field, there will be a reduction in exhaust emission levels greater than an engine that uses fossil fuels.

MATERIALS AND METHODS

The method is carried out experimentally, the data is obtained by direct observation and measurement in the field with the available measuring instruments. Experimental results data are used for analysis and later on, we will answer the objectives. Based on the research objective, the fuel needed is a mixture of gasoline (premium) and bioethanol (cassava) with a composition of the mixture is E20 (20% bioethanol and 80% gasoline), the two types of fuel are each obtained from PT Pertamina and PT WATS both has fulfilled the SNI standard (Indonesian National Standard). Furthermore, the strength of the magnetic electromagnet fields used is 647.15 Gauss, 847.25 Gauss, 1068.29 Gauss, and 1419.57 Gauss. The given magnetic field strength ranges between 500-1500 Gauss. Based on observations, the magnetic field strength of 500 Gauss is the minimum magnetic limit which affects the fuel. Less than that value, the fuel is not affected. While the value is approximately 1500 Gauss, the maximum limit of this study to compare with previous researchers who used a magnetic field strength greater than 2000 Gauss.

Table 1: Property Gasoline & Ethanol [6]

Property	Gasoline	Ethanol
C-fraction [mass %]	87.4	52.2
O-fraction [mass %]	0	34.7
Density [kg /m ³]	750-760	785-810
Stoichiometric air / fuel ratio	14.2- 15.0	9.0
Kinematic viscosity [mm ² /s]	0.5	1.3
Vapor pressure (RVP) [kPa]	53-60	17
Research octane number (RON) [-]	91-100	110
Lower heating value [MJ / kg]	44.0	27.0
Latent heat vaporization [kJ / kg]	380-400	910

The tools used in this study include the Yamaha Mio Motor in 2018, a 4-cylinder cylinder with 125cc combustion chamber, Teslameter model MG-801 for measuring magnetic field strength, NOVA 2000 gas analyzer to test exhaust emissions (CO, NO, NO_x and SO₂) and tachometer measure engine speed. The test is carried out in various rotation, 1000 rpm, 1500 rpm, and 2000 rpm.

The procedure of conducting research is shown in Figure 2. The study begins by calibrating the equipment needed, examining gasoline engine components such as lubricating oil, lubricating oil filter, fuel filter, diesel engine speed measured by a digital tachometer. In the exhaust mounted gas analyzer to observe the effects of the exhaust gas. The test begins with starting the engine at 1000 rpm and then held for ± 10 minutes to get the normal working temperature of the engine. After the machine operates normally, data retrieval starts. The independent variable is bioethanol E20 magnetized for 20 minutes [7] with variations in intensity or magnetic strength of 647.15 Gauss, 847.25 Gauss, 1068.29 Gauss, and 1419.57 Gauss, while the dependent variable in this study is the exhaust gas emissions and the heating value of the fuel, each data retrieval is repeated 5 times.

Data from the study were compared between fuels before and after magnetization and were then processed quantitatively in the form of several graphs, namely graphs of emissions levels of CO, NO, NO_x and SO₂ on rotation and magnetic strength. The results of data analysis in the form of graphs then analyzed again by referring to several reference journals listed in the bibliography.

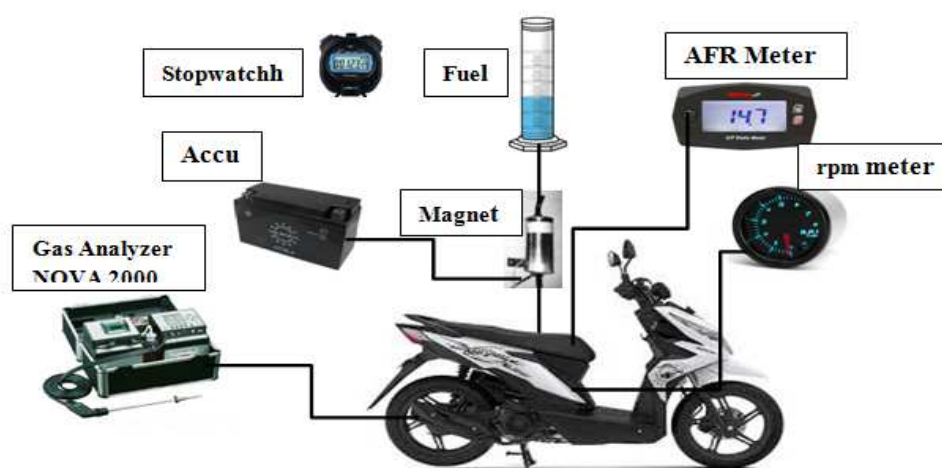


Figure 2: Diagram of the Research.

RESULTS AND DISCUSSIONS

Emission Exhaust gas is the residual combustion of fuel in the internal combustion engine, an external combustion engine, a jet engine that is released through the engine exhaust system. Some of the gases contained in exhaust emissions are CO (carbon monoxide), NO_x (nitrogen oxides), and SO₂ (sulfides). Each of these gases has its respective dangers at certain levels [8].

Carbon Monoxide (CO)

Carbon monoxide (CO) is a substance that is colorless, odorless and has no taste. CO in the form of gases occurs at temperatures above 192⁰C. This substance weights 96.5% by weight of water and is not soluble in water. Carbon monoxide contained in nature is formed through several processes, including [9][10].

- Availability of insufficient oxygen during the combustion process to convert all carbon to CO₂
- The reaction between carbon dioxide and components containing carbon at high temperatures.

Figure 3 presents a graph of the relationship between CO levels in each electromagnetic field strength variation to engine speed.

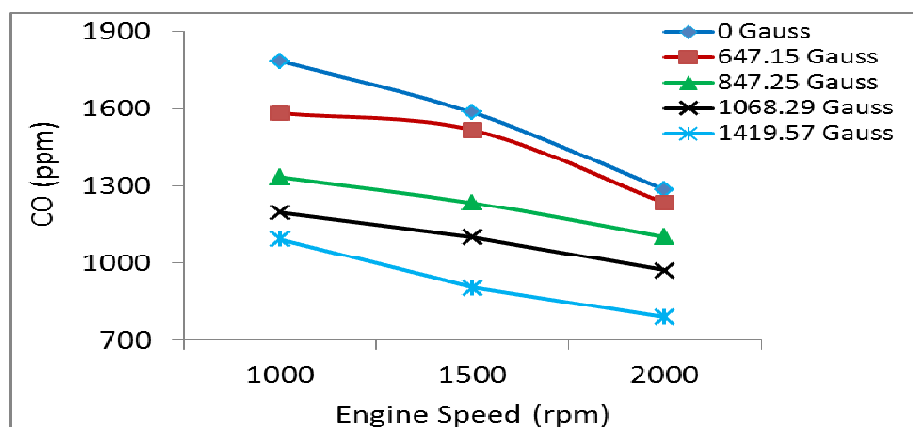


Figure 3: The Effect of Engine Speed on CO Emission at different Magnetization Fuel

In Figure 3, it explains that CO levels at 1000 rpm are higher than those at 1500 rpm and 2000 rpm. High levels of CO at 1500 engine speeds are possible because at low rotations the ignition angle tends to reverse, resulting in late combustion. The element contained in the fuel will ignite through combustion produced by spark plugs. Late combustion causes elements C and O not change to CO₂ which causes high CO emissions. CO levels decrease in the 2000 to 2500 rounds, this can be caused by the rotation when the ignition is more advanced and the combustion is not too late so that makes combustion better.

On the other hand Figure 2, also shows that fuel magnetization can reduce CO exhaust gas levels, the greater the electromagnetic field given to the fuel flow in a gasoline engine, the CO levels will decrease. This is due to the magnetized fuel molecule resulting in increased vibrations of the fuel molecule as a result of the attraction between small molecules, reduced fuel grain diameter and decreased viscosity and polarity of the fuel molecule approaching the air molecules so that the mixture of air and fuel becomes more homogeneous. Resulting in more complete combustion [7]. This complete combustion results in decreased CO exhaust emissions. CO gas emission decreases the most occurs in fuels through the electromagnetic field strength of 1419.57 Gauss and 2000 rpm engine speed, CO levels decrease by about 58%

Nitrogen Oxide (NOx)

Nitrogen oxide (NOx) is a gas found in the atmosphere consisting of gases nitric oxide and nitrogen dioxide. Nitrogen oxide is a colorless and odorless gas, whereas nitrogen dioxide has a reddish-brown color and a sharp odor. The formation of NOx in the combustion system occurs at high temperatures. Most of the NOx made by humans come from burning charcoal, oil, natural gas, and gasoline [11][12].

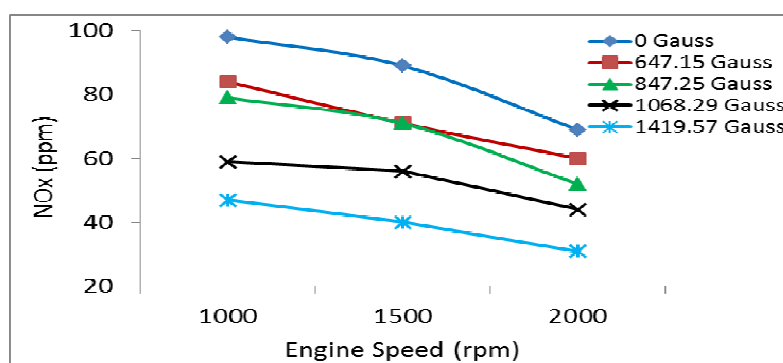


Figure 4: The Effect of Engine Speed on NOx Emission at different Magnetization Fuel.

Figure 4 shows a graph of the relationship between NOx exhaust emissions and various variations in the electromagnetic field strength. NOx exhaust emissions decreased with a increase of engine rotation. Nitrogen is relatively inert, so to act directly with air is rather difficult, but there are several causes of NOx emissions, including the high concentration of oxygen contained in the fuel plus the high temperature of the combustion chamber. Also, a pile of carbon crust in the combustion chamber will also increase engine compression and can cause hot spots that can increase NOx levels. Machines that frequently detonate will also cause high NOx concentrations.

The other side of figure 4, also shows that fuel magnetization can reduce NOx exhaust gas levels, the greater the electromagnetic field given to the fuel flow in a gasoline engine, the NOx level decreases. The cause is the same as in the CO explanation, which includes magnetized fuel which increases the polarity of the fuel molecule so that it approaches the

air molecule, resulting in a more homogeneous mixture of air and fuel resulting in more complete combustion. These results in decreased NO_x exhaust emissions. The greatest decrease in NO_x gas emissions occurs in fuels through the electromagnetic field strength of 1419.57 Gauss and 2000 rpm engine speed, NO_x levels decrease by approximately 68%

Sulfur

Oxide Pollution by sulfur oxides is mainly caused by two colorless gas components, namely sulfur dioxide (SO₂) and sulfur trioxide (SO₃), and both are referred to as SO_x. Only one-third of the amount of sulfur oxide present in the atmosphere is the result of human activities. Transportation is not the main source of SO_x pollutants, but combustion of fuel at its source is the main source of SO_x pollutants, for example burning oil, gas, and wood [13][14].

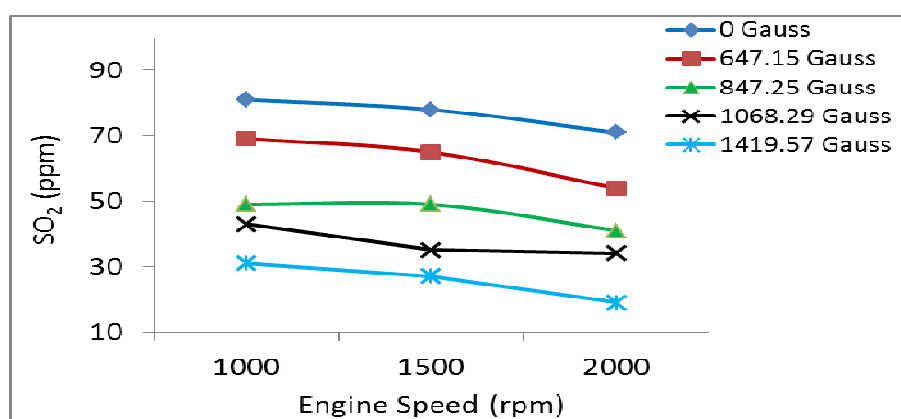


Figure 5: The Effect of Engine Speed on SO₂ Emission at different Magnetization Fuel.

Figure 5 shows a graph of the relationship between SO₂ exhaust emissions and various variations in the electromagnetic field strength. The vertical axis represents the level of SO₂ (ppm) and the horizontal axis represents the engine speed. Theoretically, the use of bioethanol as a mixture of engine fuel will reduce SO₂, because bioethanol derived from plant oils is almost free of sulfur content so that the addition of bioethanol into fuel will be able to reduce the sulfur content in the fuel itself. High levels of SO₂ at 1500 rpm engine speed are possible because at low rotations the ignition angle tends to reverse, resulting in late combustion. The element contained in the fuel will ignite through combustion produced by spark plugs. SO₂ levels decrease in 2000 to 2500 rounds, this can be due to the rotation when the ignition is more advanced and combustion is not too late so that makes combustion better. The SO₂ gas emissions' greatest decrease of around 76% occurs in fuels through the electromagnetic field strength of 1419.57 Gauss and 2000 rpm engine speed.

Figure 6 presents a graph of the relationship between combustion energy and electromagnetic field strength. It appears that the greater the magnetic field gives the greater the energy.

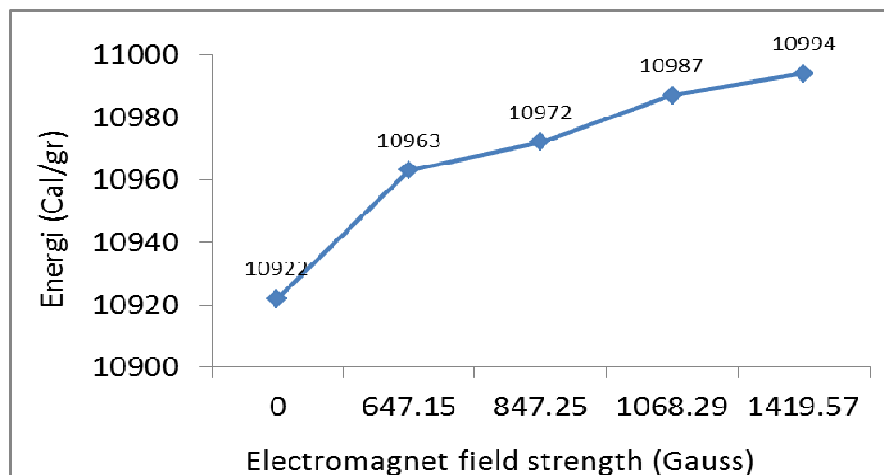


Figure 6: The Effect of Magnetic Fields at Fuel Energy.

Magnetic field strengths affect combustion energy, meaning that a lot of fuel that is burned or combusted occurs more completely. This data supports the results of emissions testing.

CONCLUSIONS

The magnetization of the E20 fuel causes;

- The greater the magnetic field strength applied to the fuel and the greater the engine speed, the smaller the level of exhaust emissions. CO exhaust emissions decreased by 48%, NO_x decreased by 6% and SO₂ decreased by 76%.
- The greater the magnetic field strength applied to the fuel the smaller the combustion energy. Combustion energy increased 0.641%, this shows that combustion that occurs is more perfect.

From all the above, it has been proven that magnets can improve the quality of exhaust emissions, and the strength of a magnetic field of 647.15 Gauss can affect fuel molecules. The weakness of this research is the amount of time the magnetic field exposure to the fuel is 20 minutes, to overcome this time, the dimensions of the galvanum pipe are made according to the rate of fuel that is sprayed into the combustion chamber.

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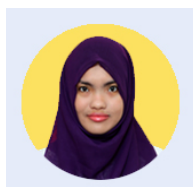
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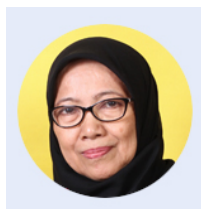
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